10/551149
JC20 Rec'd PCT/PTO 29 SEP 2005

DESCRIPTION

WATER-PERMEABLE AGENT AND FIBER APPLIED THEREWITH

Field of Invention

The present invention relates to a treatment composition suitable for fiber products, especially for fiber processed into nonwoven fabric to be employed as topsheet of disposable diapers and sanitary napkins. More precisely the present invention relates to a water-permeable agent for improving fluid-absorbing performance and permanent water permeability of top sheet, and for decreasing wetback, which means the flow back of urine or menstrual flow through topsheet to wet wearers' skin after they have been absorbed in diaper or napkin through topsheet.

Technical Background

Absorbent articles such as disposable diapers and sanitary napkins usually have a construction comprising topsheet produced by imparting hydrophilicity to various nonwoven fabrics of strongly hydrophobic polyolefin fiber, triacetate fiber or polyester fiber; backsheet imparted with hydrophobic property; and a material comprising fibrous pulp or absorbent polymer being set between the sheets. When urine or menstrual flow is absorbed into absorbent material through topsheet, topsheet must be fluid-permeable enough not to get wet, in other words, those fluids must be completely absorbed into absorbent material under topsheet in a possible shortest time. In addition, absorbed fluid in absorbent material must not flow back onto topsheet surface, in other words, wetback of absorbed fluid must be decreased. Furthermore, topsheet is required to have water

permeability durable against repeated absorption of urine, in other words, permanent water permeability, because rapid decrease of water permeability of topsheet, which is caused from the wash off of a water permeable agent from topsheet with once or twice of urine absorption, increases the frequency of exchanging diapers, and is also required to have permanent water permeability, which is not deteriorated with time. For facilitating nonwoven fabric production, a water-permeable agent applied in the production process of spun-bonded nonwovens should distribute uniformly on nonwoven fabric, penetrate sufficiently into nonwoven fabric, and attain antistaticity for controlling static charge generated in winding nonwoven sheet; and a water-permeable agent applied in a process where fiber is carded and processed into nonwoven fabric is required to attain high carding performance, in other words, to prevent static charge on fiber and fiber wrapping on card cylinder, and to facilitate uniform web processing.

For wearing comfortable diaper, diaper topsheet must have superior initial water permeability with low wetback, and superior permanent water permeability. Several arts for improving those performances by use of treating compositions have been proposed. Japanese Patent Publication Sho 63-14081 discloses a method in which fiber is treated with potassium C_{12} to C_{22} linear alkyl phosphate. Japanese Patent Laid-Open Sho 60-215870 discloses a treating composition formulated by blending a C_{10} to C_{30} alkylphosphate salt with a C_{10} to C_{30} betaine, sulfate salt, or sulfonate salt. Japanese Patent Laid-Open Hei 4-82961 discloses a method in which an alkylphosphate salt is blended with a polyether-modified silicone. Japanese Patent Laid Open 2000-170076 discloses a process wherein an alkylphosphate salt is

blended with two different betaines. Japanese Patent Laid-Open Sho 63-49158 discloses a method employing a mixture of sorbitan monooleate and polyoxyethylene sorbitan monooleate, which is different from the treating compositions mentioned above. Japanese Patent Laid-Open Hei 3-82871 discloses a method employing an alkoxylated ricinolein and hydrogenated product thereof. Japanese Patent Laid Open Hei 10-53955 discloses a method employing a combination of a polyether compound and a polyether-modified silicone. Further, Japanese Patent Laid-Open Hei 9-56748 discloses a method for decreasing wetback by modifying the construction of fiber products, in other words, disposable diapers and sanitary napkins. Japanese Patent Laid-Open 2001-123366 discloses a method for decreasing wetback by modifying the construction of topsheet of fiber products.

The water permeability, especially permanent water permeability, imparted to fiber by those conventional methods proposed above, is clearly insufficient for meeting the increasing demand in recent years. In addition, those conventional methods cannot provide sufficient fiber performance for high carding speed which is increasing with the recent increase of nonwoven production speed.

Disclosure of Invention

The object of the present invention is to provide a water-permeable agent, which attains improved water permeability and remarkably improved permanent water permeability from those attained by conventional methods, decreases wetback and time-dependent change of permanent water permeability, and is applicable to fiber processed in high-speed carding.

Another object of the present invention is to provide

fiber to which water permeability is imparted with the water permeable agent of the present invention.

Further object and advantage of the present invention are clearly illustrated in the following description.

According to the present invention, the object and advantage of the present invention mentioned above are attained by a water permeable agent comprising (A) a quaternary ammonium salt represented by the following formula (I):

$$(R^1,\ R^2,\ R^3)N^+ - R^4 \cdot X^- \quad \ldots \text{ (I)}$$

wherein R^1 is a C_8 to C_{24} aliphatic hydrocarbon group; R^2 is a C_8 to C_{18} aliphatic hydrocarbon group in the case that R^1 is a C_8 to C_{18} aliphatic hydrocarbon group, and R^2 is a hydrogen atom, C_1 to C_3 aliphatic hydrocarbon group, or C_1 to C_3 hydroxyalkyl group in the case that R^1 is a C_{19} to C_{24} aliphatic hydrocarbon group; each of R^3 and R^4 is independently a hydrogen atom, C_1 to C_3 aliphatic hydrocarbon group, or C_1 to C_3 hydroxyalkyl group; and X is an ionic residue selected from the group consisting of halogen ions, nitrate ion, acetate ion, methyl sulfate ion, ethyl sulfate ion and dimethyl phosphate ion; and (B) phosphate salt represented by the following formula (II):

$$[R^5O(R^6O)_m]_n\!-\!\overset{\displaystyle O}{\overset{\|}{P}}\!-\!(O^- \cdot Y^+)_{3-n} \quad \ldots \text{ (II)}$$

wherein R^5 is a C_6 to C_{20} aliphatic hydrocarbon group; R^6 is an ethylene and/or propylene group; m is an integer from 0 to 15; Y is an ionic residue selected from the group consisting of hydrogen ion, sodium ion, potassium ion, ammonium ion, diethanol ammonium ion, and triethanol ammonium ion; and n is an integer from 1 to 2; each of which comprises 20 to 80 weight percent and 80 to 20 weight percent of the total weight of (A) a quaternary ammonium

salt and (B) a phosphate salt.

According to the present invention, the object and advantage of the present invention mentioned above are attained, second, by providing water-permeable fiber comprising fiber and a water-permeable agent of the present invention being incorporated on the fiber at an application level from 0.1 to 2.0 weight percent of the weight of the fiber.

Best Mode of Embodiment

The quaternary ammonium salt (the component A) employed in the present invention is represented by the formula (I) described above.

In the formula (I), R^1 is a C_8 to C_{24} aliphatic hydrocarbon group; R^2 is a C_8 to C_{18} aliphatic hydrocarbon group in the case that R^1 is a C_8 to C_{18} aliphatic hydrocarbon group, and R^2 is a hydrogen atom, C_1 to C_3 aliphatic hydrocarbon group, or C_1 to C_3 hydroxyalkyl group in the case that R^1 is a C_{19} to C_{24} aliphatic hydrocarbon group; each of R^3 and R^4 is independently a hydrogen atom, C_1 to C_3 aliphatic hydrocarbon group, or C_1 to C_3 hydroxyalkyl group; and X is an ionic residue selected from the group consisting of halogen ions, nitrate ion, acetate ion, methyl sulfate ion, ethyl sulfate ion and dimethyl phosphate ion.

One of or a combination of two or more of the quaternary ammonium salts represented by the formula (I) can be employed.

In the above formula (I), each of R^1 and R^2 is independently and preferably a C_8 to C_{18} aliphatic hydrocarbon group. R^1 or R^2 having carbon atoms equal to or smaller than 7 is not preferable, because such aliphatic hydrocarbon group accelerates the time-dependent deterioration of permanent water

permeability, deteriorates fiber processability in carding, excessively increases hydrophilicity of fiber to decrease permanent water permeability, and increases wetback. R^1 or R^2 having carbon atoms equal to or greater than 25 is not preferable, because such aliphatic hydrocarbon group is apt to decrease initial water permeability.

Each of R^3 and R^4 is preferably a C_1 to C_3 aliphatic hydrocarbon group. R^3 or R^4 having carbon atoms equal to or greater than 4 is not preferable, because such aliphatic hydrocarbon group is apt to decrease the initial and permanent water permeability of resultant water-permeable agent.

The examples of the preferable component (A) are dioctyl dimethyl ammonium chloride, didecyl dimethyl ammonium chloride, dilauryl dimethyl ammonium chloride, distearyl dimethyl ammonium chloride, di-coco-alkyl dimethyl ammonium chloride, di-hydrogenated-tallow alkyl dimethyl ammonium chloride, behenyl trimethyl ammonium chloride, dilauryl dimethyl ammonium methosulfate, and dilauryl methylethyl ammonium ethosulfate.

Some components similar to the specific quaternary ammonium salt (A) employed for the water-permeable agent of the present invention have been disclosed, such as a quaternary ammonium phosphate being added to an antistatic component described in Claim 1 of Japanese Patent Laid-Open Sho 61-289182, and soya-dimethylethyl ammonium ethosulfate being added to a finish for fiber processed in open-end spinning described in Examples 1 to 6 in the specification of USP 4816336. The former contains a C_8 to C_{18} hydrocarbon group bonded to a nitrogen atom of the quaternary ammonium, and the latter contains a C_{16} to C_{18} hydrocarbon group bonded to a nitrogen atom

of the ammonium. Both of those components have excessive hydrophilicity which fails to impart permanent hydrophilicity to fiber, because the former contain a C_8 to C_{18} hydrocarbon group bonded to the nitrogen atom of a quaternary ammonium, the latter contain a C_{16} to C_{18} hydrocarbon group bonded to the nitrogen atom of an ammonium, and both of those components contain only one hydrocarbon group in one molecule.

The ratio of the component (A) is from 20 to 80 weight percent, preferably 25 to 75 weight percent, of the total of the components (A) and (B). A ratio smaller than 20 weight percent results in poor permanent water permeability, which deteriorates greatly with time. A ratio greater than 80 weight percent results in poor fiber processability in carding and increased wetback.

The phosphate salt (the component B) employed in the present invention is represented by the formula (II) described above. In the formula (II), R^5 is a C_6 to C_{20} aliphatic hydrocarbon group; R^6 is an ethylene and/or propylene group; m is an integer from 0 to 15; Y is an ionic residue selected from the group consisting of hydrogen ion, sodium ion, potassium ion, ammonium ion, diethanol ammonium ion, and triethanol ammonium ion; and n is an integer from 1 to 2.

One of or a combination of two or more of the phosphate salts represented by the formula (II) can be employed.

In the formula (II) mentioned above, R^5 is preferably a C_8 to C_{18} aliphatic hydrocarbon group. R^5 having carbon atoms equal to or smaller than 5 is not preferable, because such aliphatic hydrocarbon group results in poor fiber processability in carding, decreased permanent water permeability of fiber due to its excessive hydrophilicity, and increased wetback. R^5 having carbon atoms equal to or greater than 21 is not preferable,

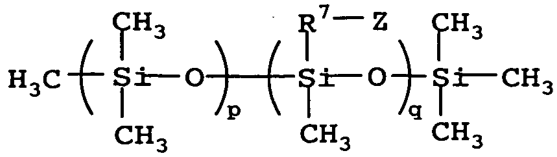
because such aliphatic hydrocarbon group decreases initial water permeability, and is apt to decrease permanent water permeability.

The number, m, is preferably an integer ranging from 0 to 10, and a value of m greater than or equal to 16 is not preferable, because it leads to decreased initial water permeability and accelerates the solidification of the component (B) resulting in difficult handling of a water-permeable agent.

The examples of the preferable component B are sodium hexyl phosphate, sodium octyl phosphate, potassium octyl phosphate, potassium decyl phosphate, potassium lauryl phosphate, potassium myristyl phosphate, potassium cetyl phosphate, potassium stearyl phosphate, potassium behenyl phosphate, POE (4) sodium decyl phosphate, POE (3) sodium lauryl phosphate, POE (2) potassium cetyl phosphate, POE (15) potassium cetyl phosphate, EO (6)/PO (2) sodium lauryl phosphate, POE (3) diethanolamine lauryl phosphate, and POE (3) triethanolamine lauryl phosphate.

The ratio of the component (B) is from 20 to 80 weight percent, preferably from 25 to 75 weight percent, of the total of the components (A) and (B). A ratio smaller than 20 weight percent results in poor fiber processability in carding, and a ratio greater than 80 weight percent results in insufficient pickup of the component (A) on fiber leading to poor permanent water permeability.

Blending polyoxyalkylene-modified silicone (the component C) represented by the formula (III) shown below to the components (A) and (B) by 5 to 20 weight percent of the total of the components (A) and (B) improves the permanent water permeability and fiber processability in carding attained by the water-permeable agent of the present invention:



···(III)

in the formula (III), R^7 is a methylene group, ethylene group, propylene group, N-(aminoethyl) methylimino group, or N-(aminopropyl) propylimino group; Z is a polyoxyalkylene group containing at least 20 weight percent of polyoxyethylene; and p and q are integers selected within a range of numbers which produce a component (C) having a molecular weight of 1,000 to 100,000 and containing 20 to 70 weight percent of silicon.

The examples of polyoxyalkylene groups employable as Z are polyoxyethylene groups, polyoxypropylene groups, polyoxybutylene groups, and copolymers of those monomers. A polyoxyalkylene group containing less than 20 weight percent of polyoxyethylene groups cannot attain sufficient initial and permanent water permeability.

Integers p and q resulting in less than 20 weight percent of silicon in a component (C) is not preferable because of insufficient carding performance and rarely improved permanent water permeability of fiber applied with resultant water-permeable agent, and integers p and q resulting in more than 70 weight percent of silicon in a component (C) is not preferable too because of the instability and high production cost of resultant water-permeable agent. Integers p and q resulting in a molecular weight of a component (C) beyond the range of 1,000 to 10,000 are not preferable because of rarely improved initial and permanent water permeability of fiber applied with resultant water-permeable agent.

Blending the component (C) to the water-permeable agent of the present invention improves permanent water permeability and fiber processability in carding. The

preferable ratio of the component (C) in the water-permeable agent is from 5 to 20 weight percent as mentioned above. A ratio less than 5 weight percent cannot improve permanent water permeability and fiber processability in carding to a satisfactory level, and a ratio greater than 20 weight percent tends to produce unstable water-permeable agent and increases production cost though it contributes to improved permanent water permeability.

The water-permeable agent of the present invention is applied to synthetic fibers, natural fibers, and products thereof; preferably to hydrophobic synthetic fibers, for example, polyolefin, polyester, triacetate, nylon, and vinyl chloride, and products thereof; and to thermo-bondable synthetic fibers, such as fibrillated polyolefin, or those having sheath-core structure comprising polyester and polyethylene, polyester and polypropylene, polypropylene and polyethylene, low-melting-point polypropylene and polypropylene, or low-melting-point polyester and polyester, and products thereof. Preferable examples of the products mentioned above are nonwoven fabric products, especially those applied as topsheet of disposable diapers and sanitary napkins.

The water-permeable agent of the present invention can be applied to fiber, which is processed into nonwoven fabric, at a stage optionally selected in fiber production process, such as spinning, drawing, and crimping, with a known application method, and can be applied in nonwoven fabric production process such as spun-bonding, water-needling, and melt-blowing, with an ordinary application method.

The water-permeable agent of the present invention can be applied to fiber from aqueous emulsion or dilution

with solvent. An aqueous emulsion of 5 to 30 weight percent concentration of the agent or a dilution of 5 to 30 weight percent concentration of the agent diluted with a low-viscosity hydrocarbon can be applied to fiber with known application method, such as kiss-roll application, spraying, and bath immersion.

The water-permeable agent of the present invention is applied to fiber usually from 0.1 to 2.0 weight percent, preferably from 0.3 to 0.7 weight percent of fiber weight. An amount of said agent on fiber less than 0.1 weight percent results in insufficient initial and permanent water permeability, poor antistaticity, and poor lubricity. An amount of said agent on fiber more than 2.0 weight percent increases fiber wrapping trouble in carding leading to significant decrease of fiber production efficiency, and gives sticky touch on fiber products, such as nonwovens, after water passes through fiber products.

Some components other than those described above can be added to the water-permeable agent of the present invention so far as they do not deteriorate the object of the present invention. Components which can be added to said water-permeable agent are lubricants, such as emulsified carnauba wax, nonionic surfactants, anionic surfactants other than phosphates, anti-foaming agents, and antiseptics.

The water-permeable agent of the present invention enables the production of nonwoven fabrics having significantly improved initial and permanent permeability of urine and menstrual flow and decreased time-dependent deterioration of permanent water permeability and wetback by applying said water-permeable agent to nonwoven fabric or to fiber processed into nonwoven fabric. In addition, said

water-permeable agent significantly improves fiber separation and fiber processability in carding in nonwoven fabric production process, because it improves the antistaticity and lubricity of fiber.

Examples

The present invention is explained with the following examples though the present invention is not restricted within the scope of those examples. The tested properties and testing procedures for Examples and Comparative Examples are as follows. The formulae of the agents and test results of Examples and Comparative Examples are summarized in Table 1 and Table 2. The ratios of the components of the agents are represented by weight percent.

Each of the agents of Examples and Comparative Examples was applied to a fiber, which had been deoiled with hot water prior to the application of the agents with such a ratio that the active content of the applied agent was 0.5 weight percent of the fiber weight, and the fiber samples applied with the agents were dried. Then each of the fiber samples was processed through opening and carding to be processed into web having a density of 30 g/m^2. The web samples were then heated at 130 °C in an air-through convection oven to fix single fibers of web samples. The resultant nonwoven fabric samples were tested with the following testing procedures to check their water permeability.

Carding performance: The processability of a fiber sample in carding was evaluated by observing mainly the wrapping of the fiber sample on a card cylinder at 30 °C and 70 %RH. The antistaticity of the fiber sample was evaluated by determining the static charge on the sample at 20 °C and 45 %RH. Each of the performances was ranked

as follows.

Processability in carding: Forty grams of a fiber sample was processed with a carding machine at 30 °C and 70 %RH, and the cylinder of the carding machine was inspected after carding operation to evaluate and rank the processability of the fiber sample in carding as follows; 5 representing no wrapping, 4 representing fiber wrapping on 1/10 of the cylinder surface, 3 representing fiber wrapping on 1/5 of the cylinder surface, 2 representing fiber wrapping on 1/3 of the cylinder surface, and 1 representing fiber wrapping on the whole of the cylinder surface. The ranks 5 and 4 are acceptable, and the rank 5 is the best.

Antistaticity: Forty grams of a fiber sample was processed into web with a carding machine at 20 °C and 45 %RH, and the static charge on the web was determined and ranked as follows; 5 representing static charge lower than 100 V, 4 representing static charge ranging from 0.1 to 1.0 kV, 3 representing static charge ranging from 1.0 to 1.5 kV, 2 representing static charge ranging from 1.5 to 2.0 kV, and 1 representing static charge higher than 2.0 kV. The ranks 5 and 4 are acceptable, and the rank 5 is the best.

Wetback through nonwoven fabric: A nonwoven fabric sample cut into 10 cm square was placed on a commercially available disposable diaper. A tube of 70 mm inside diameter was set upright on the nonwoven fabric sample, and 100 ml of physiological salt solution was poured into the tube to be absorbed into the diaper through the nonwoven sample. After all of the solution was absorbed into the diaper, the tube was removed and twenty sheets of filter paper (Toyo Roshi, No. 5) previously weighed were piled up on the area of the absorption on the diaper. Then a 5-kg weight was placed on the piled filter paper.

After 5 minutes, the 20 sheets of the filter paper were weighed and the increased weight was determined as the weight (g) of wetback solution. A wetback quantity equal to or smaller than 1.5 g is acceptable, and preferable level is 1.0 g or less.

Initial water permeability of nonwoven fabric: A sheet of a nonwoven fabric sample having a density of 30 g/m^2 was placed on filter paper (Toyo Roshi, No. 5). One drop (about 0.05 ml) of artificial urine was dropped onto the nonwoven fabric sample from the mouth of a burette fixed 10 mm above the nonwoven sample, and the time required for the drop disappearing from the nonwoven fabric surface was checked. The same operation was performed twenty times at different points of the nonwoven fabric surface, and the number of drops disappeared within 5 seconds was counted. The number of the counted drops equal to or greater than 18 represents that the nonwoven fabric sample has sufficient initial water permeability.

Permanent water permeability of nonwoven fabric: The 10-cm square nonwoven fabric sample described above was placed on a commercially available diaper. A tube of 70 mm inside diameter was set upright on the nonwoven fabric sample, and 50 ml of artificial urine was poured into the tube to be absorbed into the diaper through the nonwoven sample. After 3 minutes, the nonwoven fabric sample was sandwiched between ten sheets of filter paper (Toyo Roshi, No. 5). A 10-cm square board was placed on the filter paper, and a 3.7-kg weight was placed on the board for 3 minutes to dehydrate the nonwoven fabric sample. Then nonwoven fabric sample was dried at room temperature for 5 minutes. The area of the nonwoven fabric sample through which the artificial urine passed was tested in the testing procedure of the initial water permeability of

nonwoven fabric by counting the number of drops of artificial urine disappeared within 5 seconds after placed on twenty different points on the area. The number of the counted drops equal to or greater than 18 represents that the nonwoven fabric sample has sufficient water permeability. The same area of the nonwoven fabric sample was repeatedly tested in the same manner, and a nonwoven fabric sample on which more artificial urine drops disappear within 5 seconds through the repeated testing is evaluated to have better permanent water permeability.

Water permeability after storage: The 10-cm square nonwoven fabric sample described above was stored in a incubator at 40 °C and 70 %RH for 30 days. After 30 days, the nonwoven fabric sample was taken out of the incubator, and the initial water permeability and permanent water permeability of the nonwoven fabric sample were tested. A nonwoven fabric sample exhibiting smaller difference in the initial water permeability and permanent water permeability before and after the storage in the incubator is evaluated to have permanent water permeability with lower degree of time-dependent change. Lower degree of the time-dependent change is preferable.

Examples 1 to 8 and Comparative Examples 1 and 2

Table 1

Test No.		C.Ex.1	Ex. 1	Ex. 2	C.Ex.2	Ex. 3	Ex. 4	Ex. 5	Ex. 6	Ex. 7	Ex. 8
Ratio (weight percent)	Component A1	40	40	40	40	70	40			40	40
	A2							40			
	A3								40		
	B1	60	60	60	60	30	50	60	60		
	B2									60	
	B3										60
	C1						10				
O.P.U. (%)		0.1	0.5	1.0	2.2	0.5	0.5	0.5	0.5	0.5	0.5
Carding performance	Processability	5	5	5	2	5	5	5	5	5	5
	Antistaticity	2	5	5	5	5	5	5	5	5	5
Water permeability of nonwoven fabric	Initial	14	20	20	--	20	20	20	19	20	19
	Permanent										
	1st	10	20	20	--	20	20	20	20	20	20
	2nd	3	20	20		20	20	20	20	20	20
	3rd	0	18	20		20	20	19	20	17	16
	4th		12	17		16	15	14	15	10	9
	5th		6	10		8	8	7	9	5	5
	Wetback (g)	0.5	0.9	1.2	--	1.0	1.0	0.8	0.7	1.0	0.7
Water permeability of nonwoven fabric after storage	Initial	12	20	20	--	20	20	19	18	20	18
	Permanent										
	1st	7	20	20	--	20	20	20	20	20	20
	2nd	2	18	20		20	20	19	20	17	17
	3rd	0	13	18		15	16	16	18	11	10
	4th		7	10		9	10	9	11	6	5
	5th		3	5		4	5	5	7	2	2

Ex.: Example
C.Ex.: Comparative Example

Comparative Examples 3 to 10

Table 2

Test No.		C.Ex.3	C. Ex. 4	C.Ex.5	C.Ex.6	C.Ex.7	C.Ex.8	C.Ex.9	C.Ex.10
Ratio (weight percent)	Component A1	15	85			40	40	40	
	A4			40					
	A5				40				
	A6								40
	B1	85	15	60	60				60
	B4					60			
	B5						60		
	B6							60	
O.P.U. (%)		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Carding performance	Processability	5	3	3	5	3	5	5	4
	Antistaticity	5	5	5	5	5	4	5	5
Water permeability of nonwoven fabric	Initial	19	20	20	14	20	12	15	20
	Permanent								
	1st	20	20	20	17	20	12	20	19
	2nd	16	20	12	10	11	6	20	11
	3rd	7	20	5	4	3	2	10	4
	4th	3	17	0	0	0	0	4	0
	5th	0	12					0	
	Wetback (g)	0.9	2.0	1.7	0.7	2.0	0.7	0.9	1.6
Water permeability of nonwoven fabric after storage	Initial	18	20	20	10	20	10	14	17
	Permanent								
	1st	17	20	16	15	16	10	20	16
	2nd	10	20	8	6	8	5	18	7
	3rd	5	18	2	0	0	0	8	0
	4th	0	10	0				3	
	5th		6					0	

Ex.: Example
C.Ex.: Comparative Example

The components described in Table 1 and Table 2 are as follows.

A1 is dilauryl-dimethyl ammonium chloride, A2, distearyl-dimethyl ammonium chloride, A3, behenyl-trimethyl ammonium chloride, A4, lauryl-trimethyl ammonium chloride, A5, trilauryl-methyl ammonium chloride, and A6, soya-dimethyl-ethyl ammonium ethosulfate.

B1 is POE (3) lauryl ether diethanol ammonium phosphate, B2, POE (3) decyl ether diethanol ammonium phosphate, B3, POE (2) cetyl ether potassium phosphate, B4, potassium butyl phosphate, B5, potassium behenyl phosphate, and B6, POE (20) lauryl ether diethanol ammonium phosphate.

C1 is polyoxyethylene-modified silicone of 10,000 molecular weight containing 65 weight percent of silicon.

The agents of Examples 1 to 8, which were formulated according to the components and ratios specified in the present invention, exhibited satisfactory result, attaining sufficient permanent water permeability, small quantity of wetback, and low degree of time-dependent change of water permeability. On the contrary, the agents of Comparative Examples 1 to 9, which were formulated with the components and ratios out of the specification of the present invention, could not attain all of the required performance. The result proves the synergism of the components formulated in proper ratios. Any one or more of initial water permeability, permanent water permeability, wetback, water permeability after storage, fiber processability in carding, and stability and handling performance of an agent attained by each agent of Comparative Examples were inferior to those attained by each agent of Examples.

As described above, the water-permeable agent of the

present invention, being incorporated on hydrophobic fibers, such as polypropylene, or nonwoven fabric thereof with spraying or other methods, imparts initial and permanent water permeability, and decreases time-dependent change of water permeability and wetback of urine and menstrual flow.